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Barber

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(54) **WIND TURBINE WITH PAIRED GENERATORS**

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(51) **Int. Cl.**

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H02P 9/04	(2006.01)
F03D 7/02	(2006.01)
B63H 1/06	(2006.01)

(52) **U.S. Cl.** ..... **290/55**; 290/44; 416/41; 416/132 B

(58) **Field of Classification Search** ..... 290/44, 290/55; 416/41, 132 B

See application file for complete search history.

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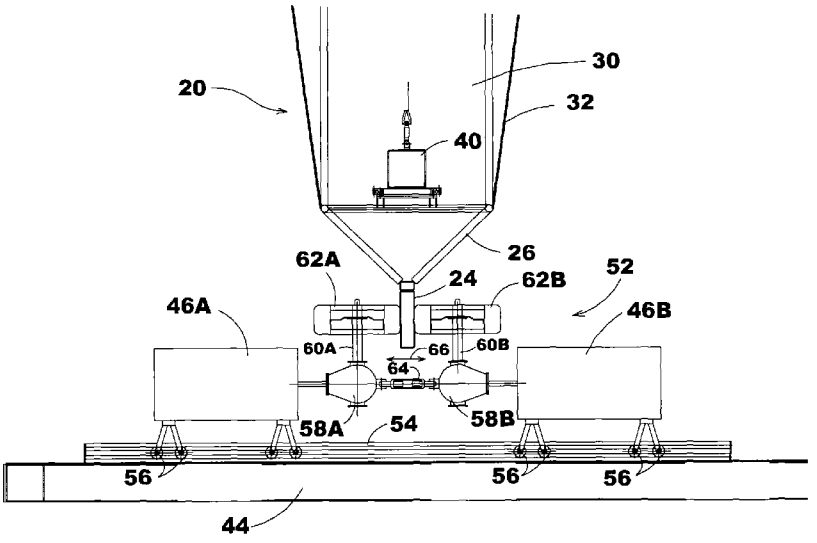
(57) **ABSTRACT**

A wind turbine **20** has a turbine wheel **22** with a perimeter rim **24** and/or an intermediate rim **117** that are concentric with the axis of rotation of the turbine wheel. Electrical generators **46** and **48** are placed in engagement with the rims, with the generators formed in pairs that engage opposite surfaces of the rims. The electrical generators are mounted so that they may move laterally in response to the axial "wobble" likely to occur in the rims of the turbine wheel.

17 Claims, 10 Drawing Sheets



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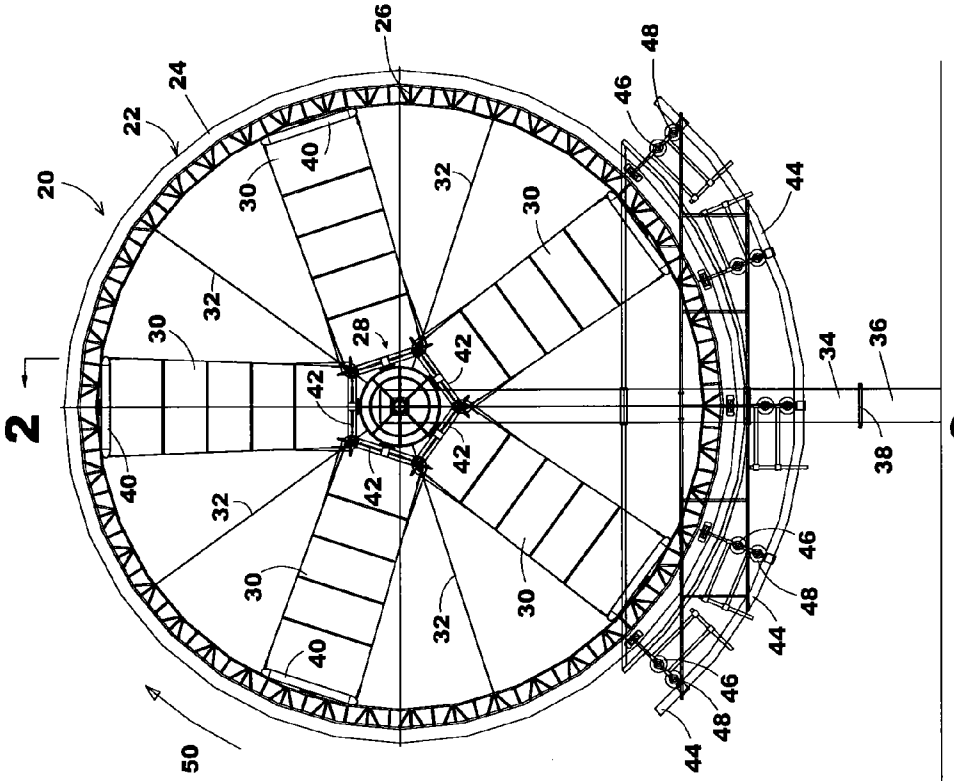
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FIG. 1

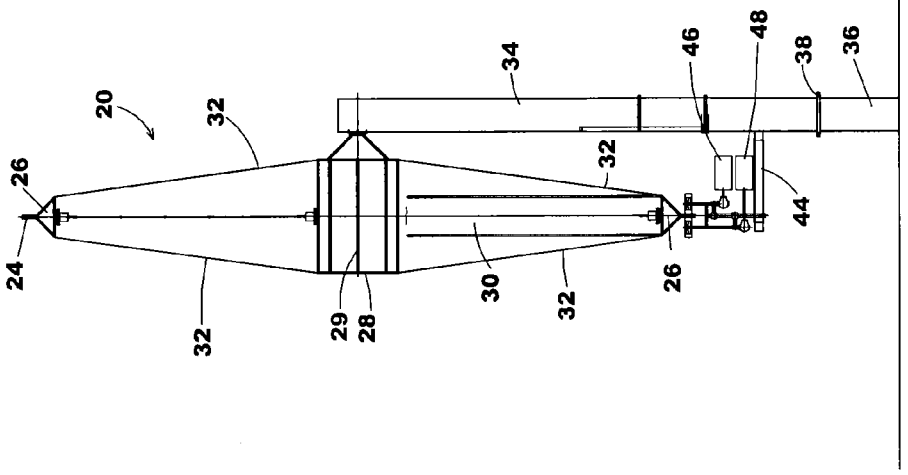
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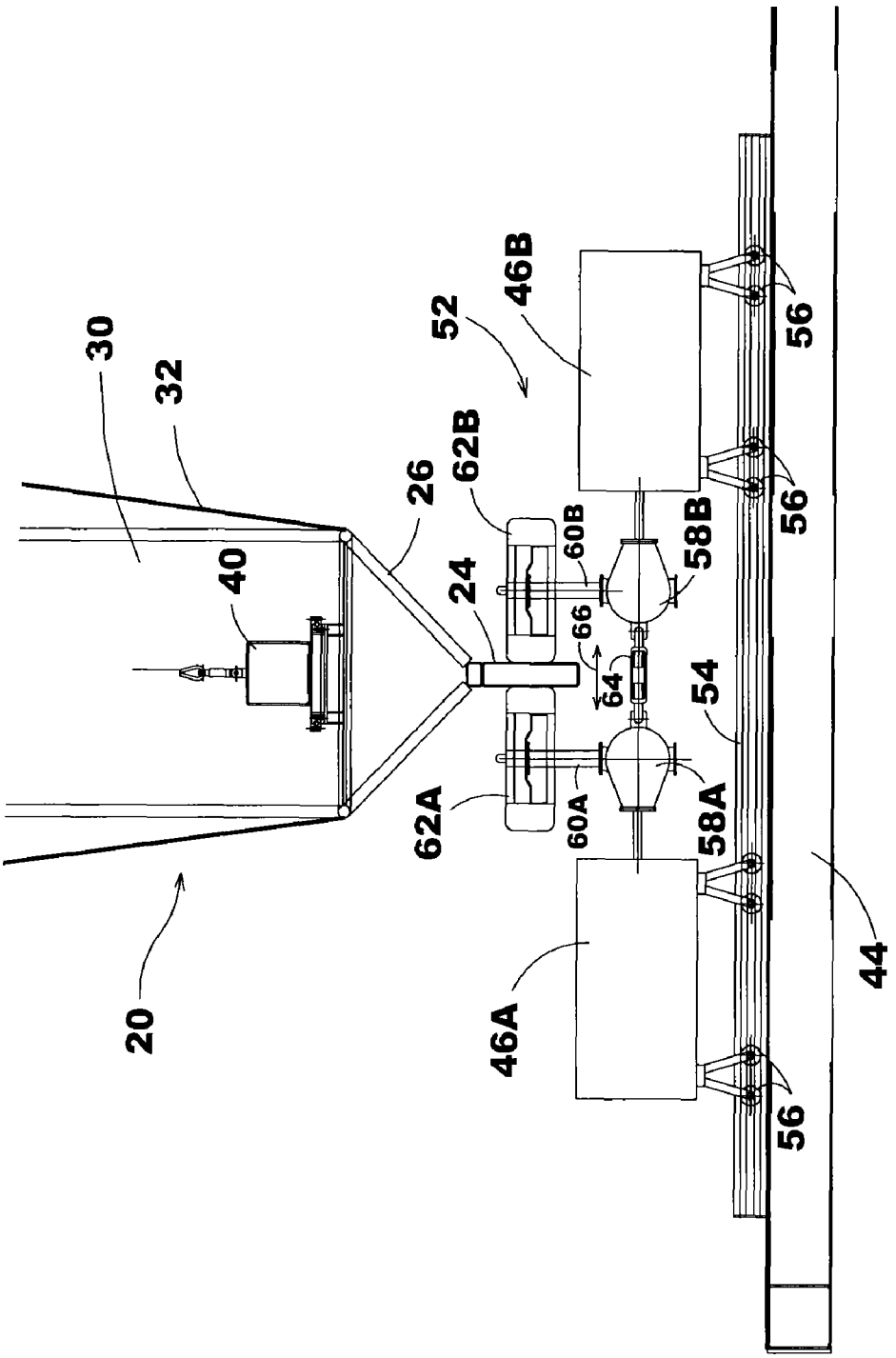
FIG. 2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32
40
20
26
24
62B
62A
60B
60A
66
64
52
46B
46A
58B
58A
54
56
56
56
44

FIG. 3

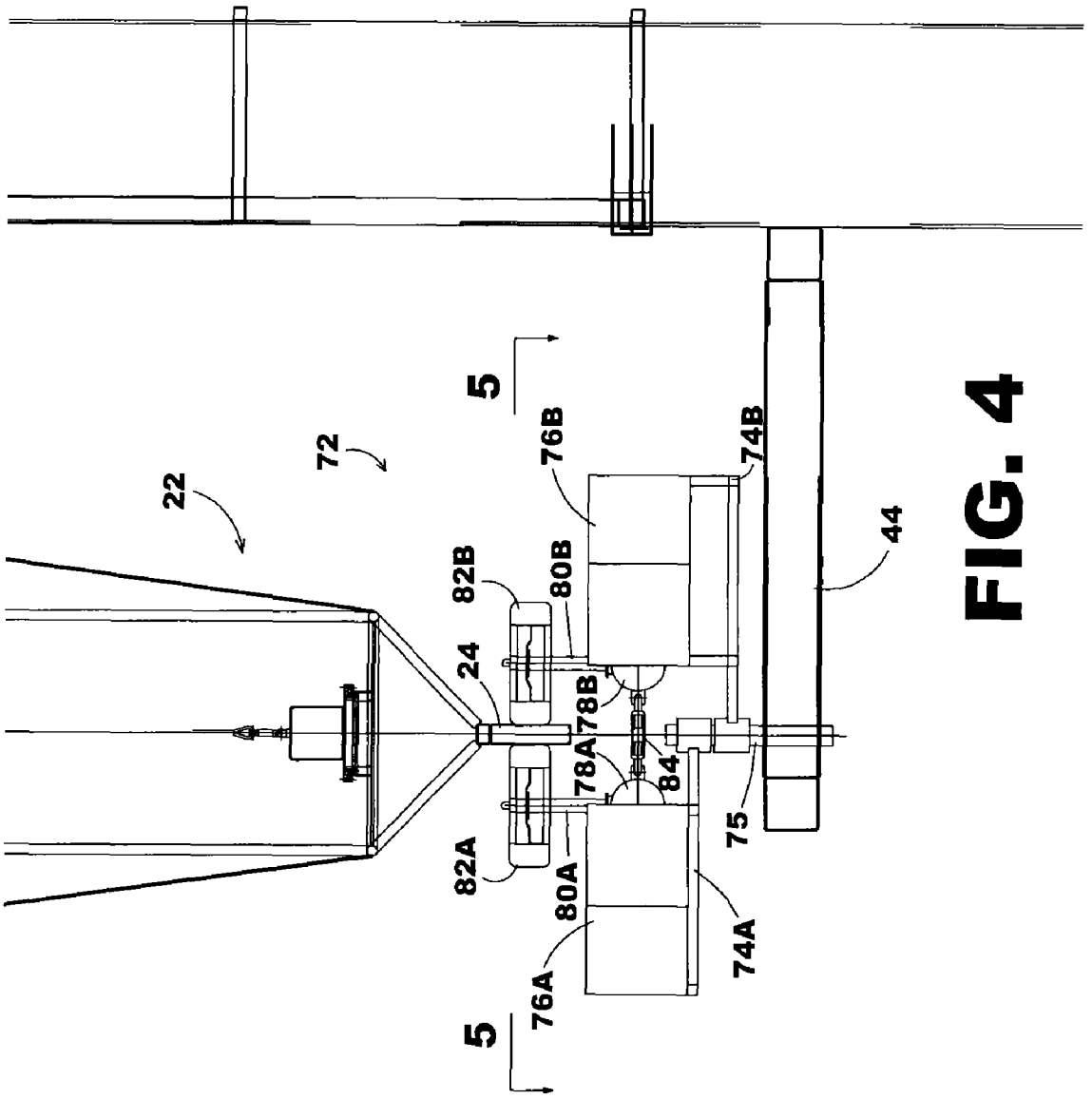


FIG. 4

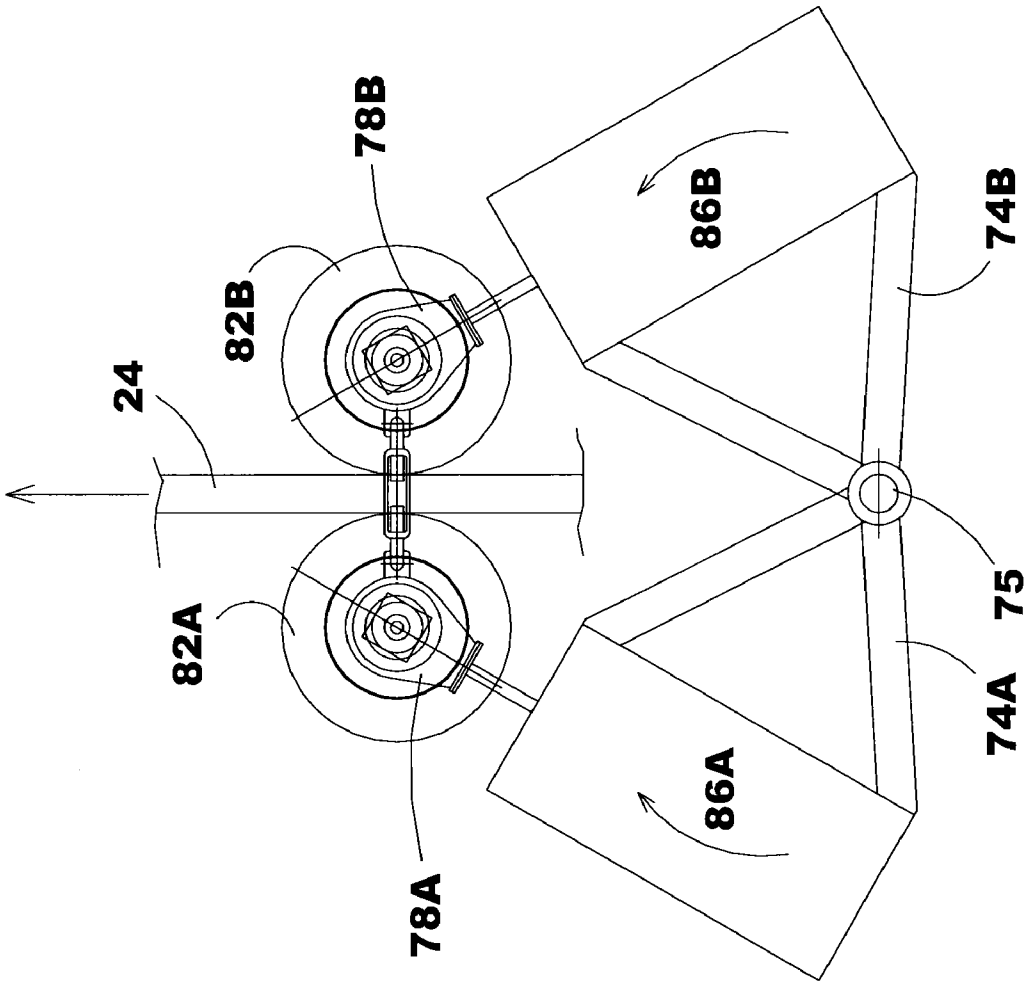


FIG. 5

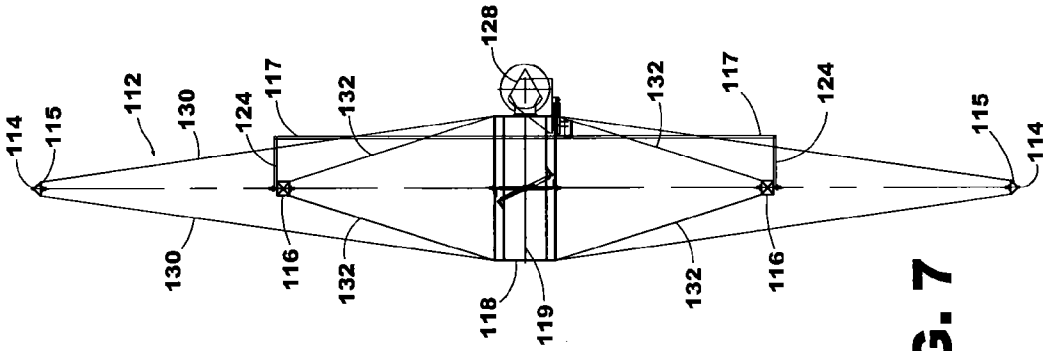

114
115
112
130
124
117
132
128
132
117
124
115
114
130
116
132
118
119
132
116

FIG. 7

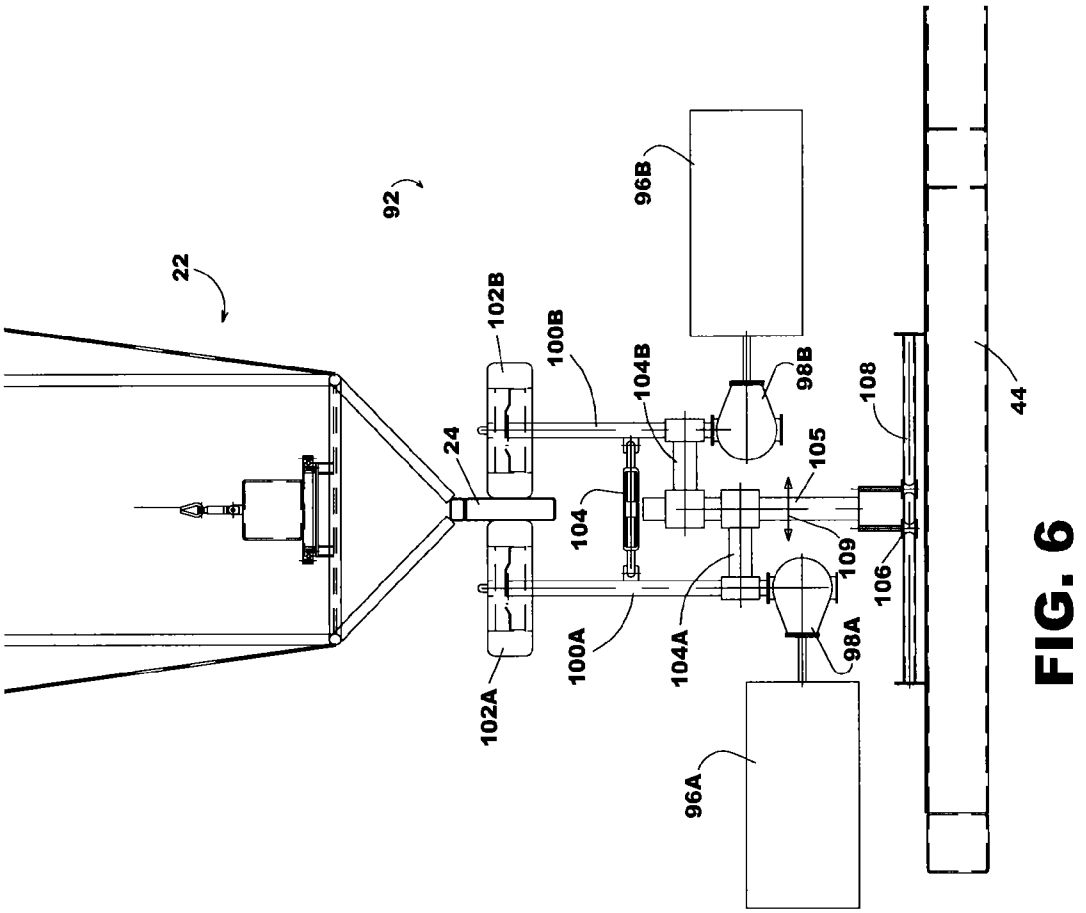

22
92
96B
102B
100B
104B
98B
24
108
44
105
104
109
106
100A
104A
98A
102A
96A

FIG. 6

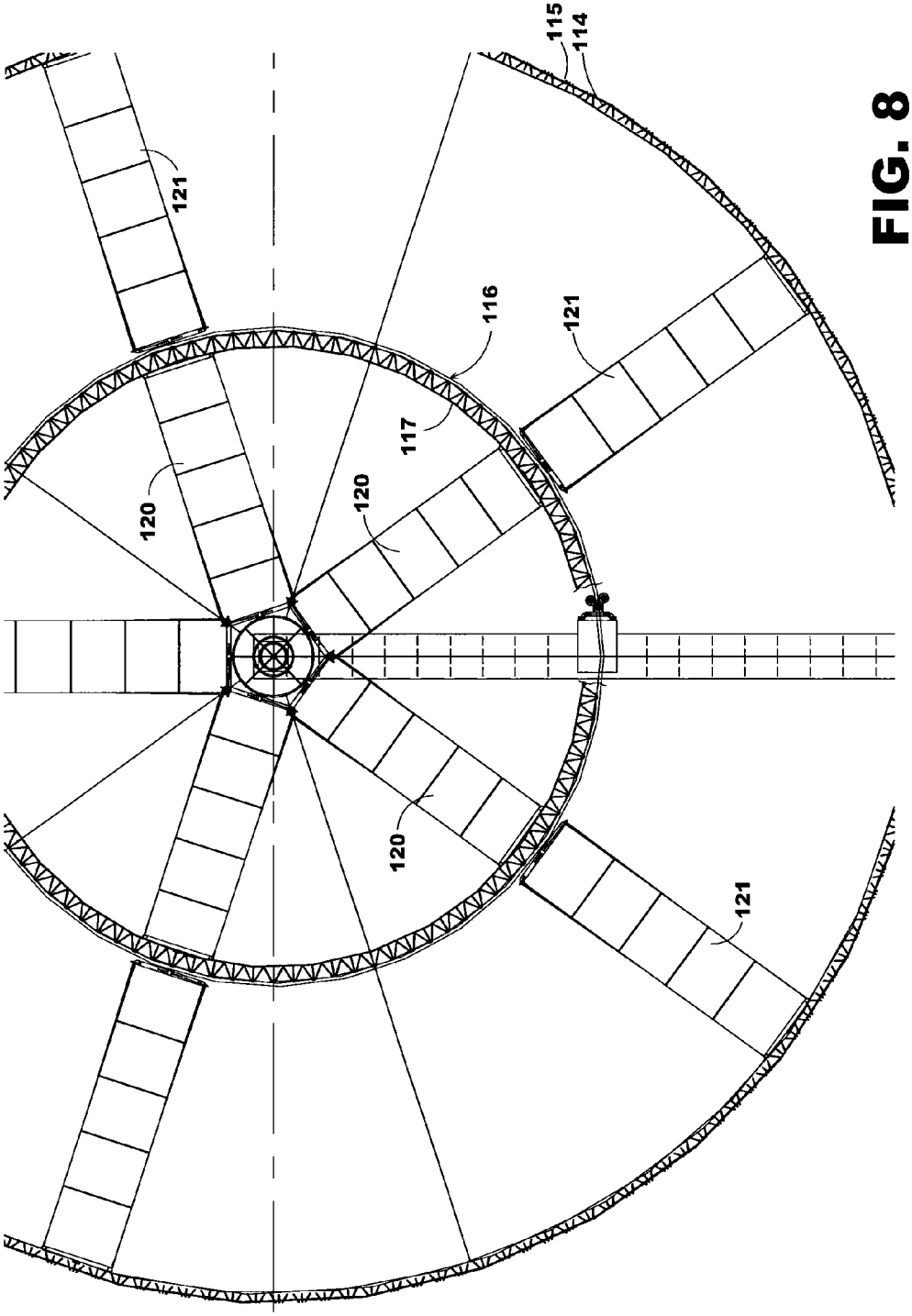


FIG. 8

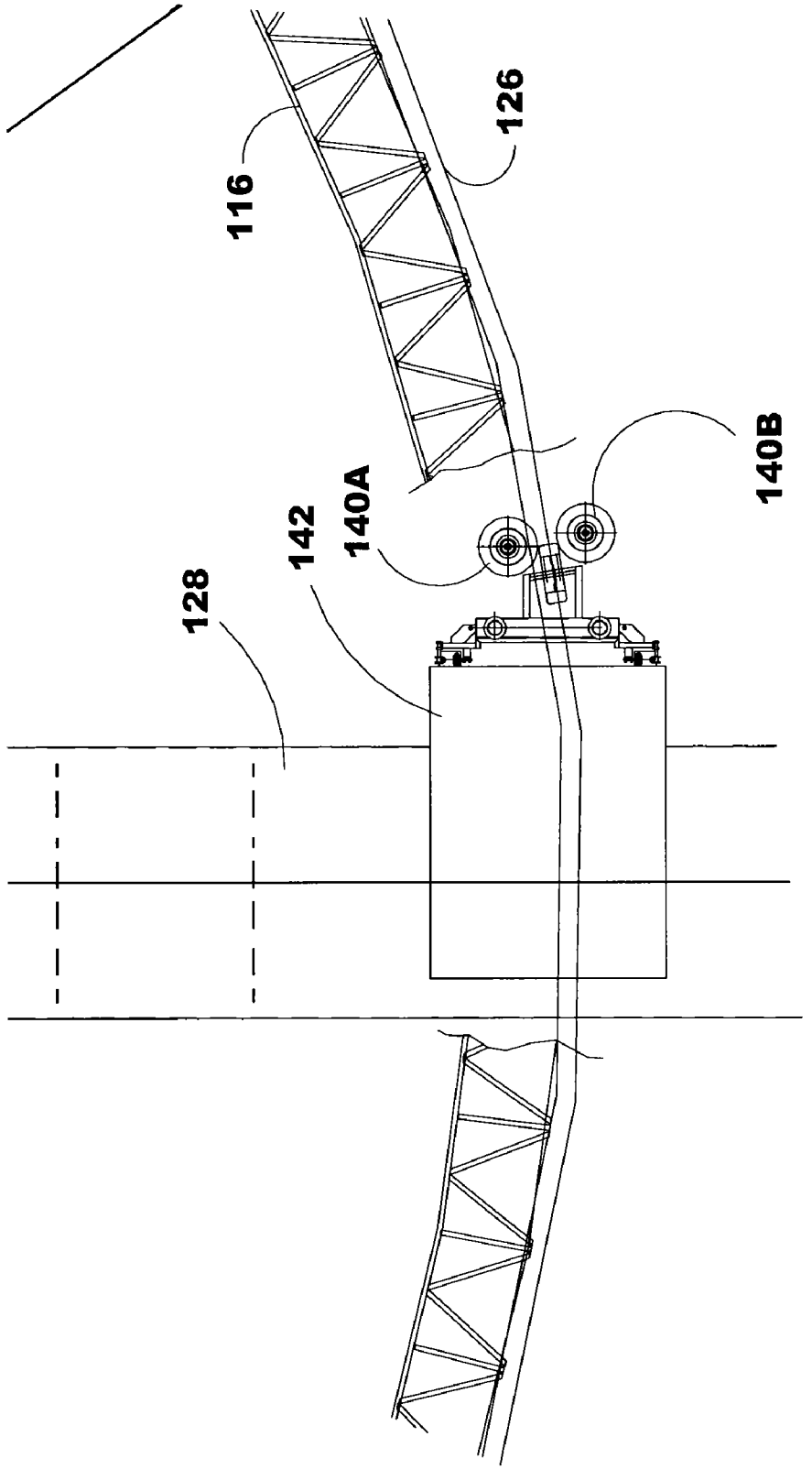
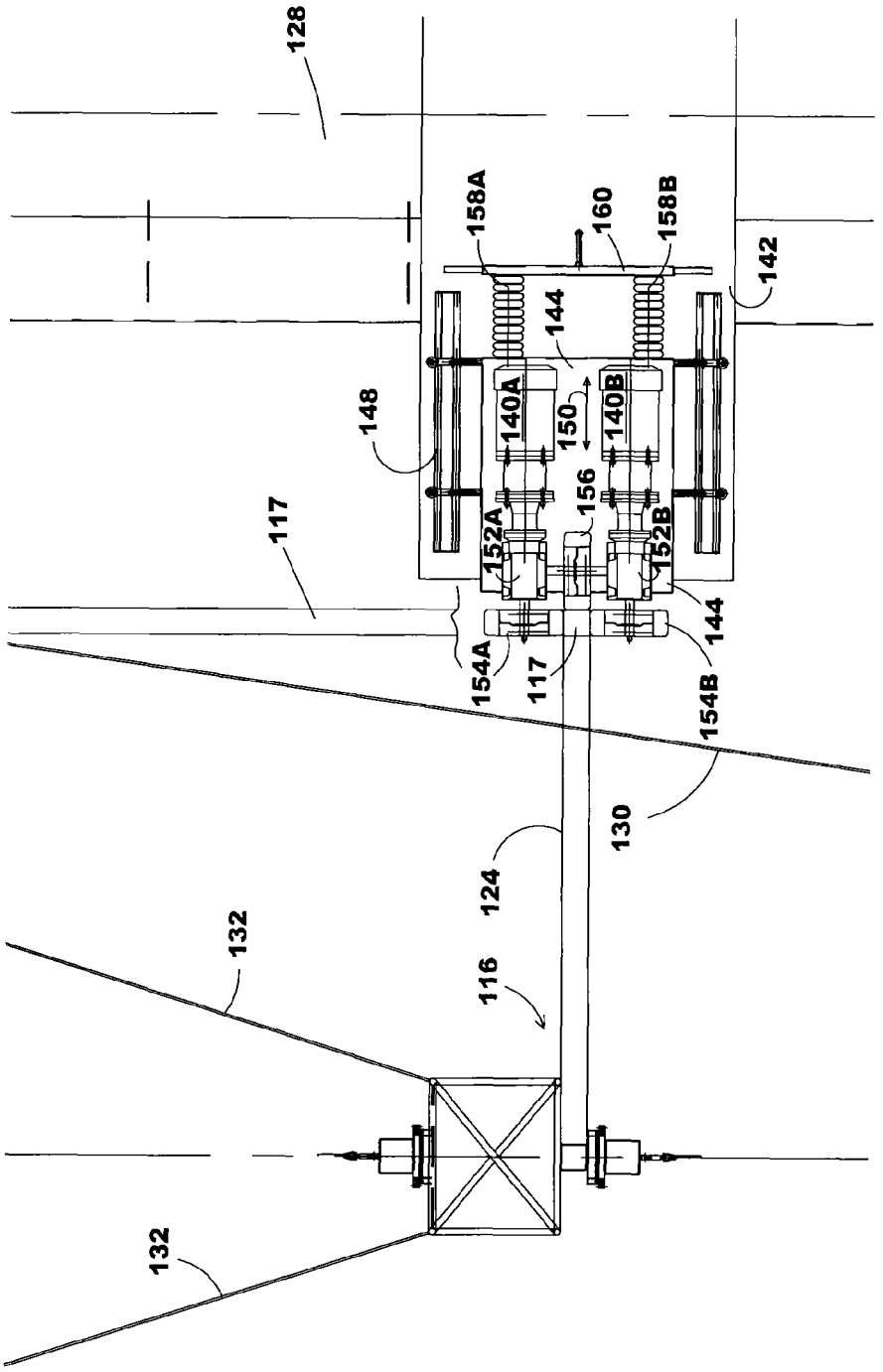


FIG. 9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158A
160
158B
142
144
148
140A
150
140B
156
117
152A
152B
144
154A
117
154B
130
124
132
116
132

FIG. 10

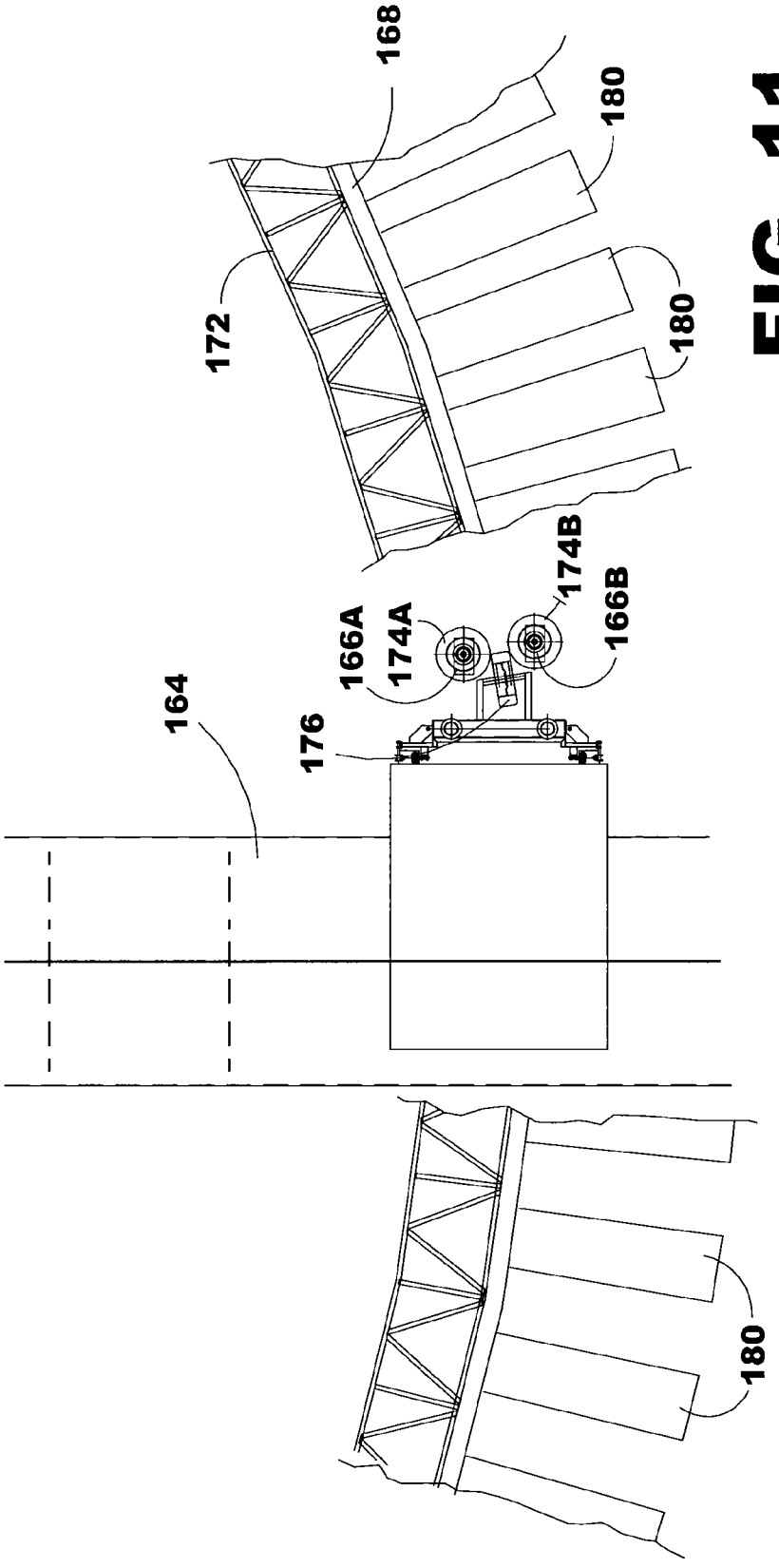
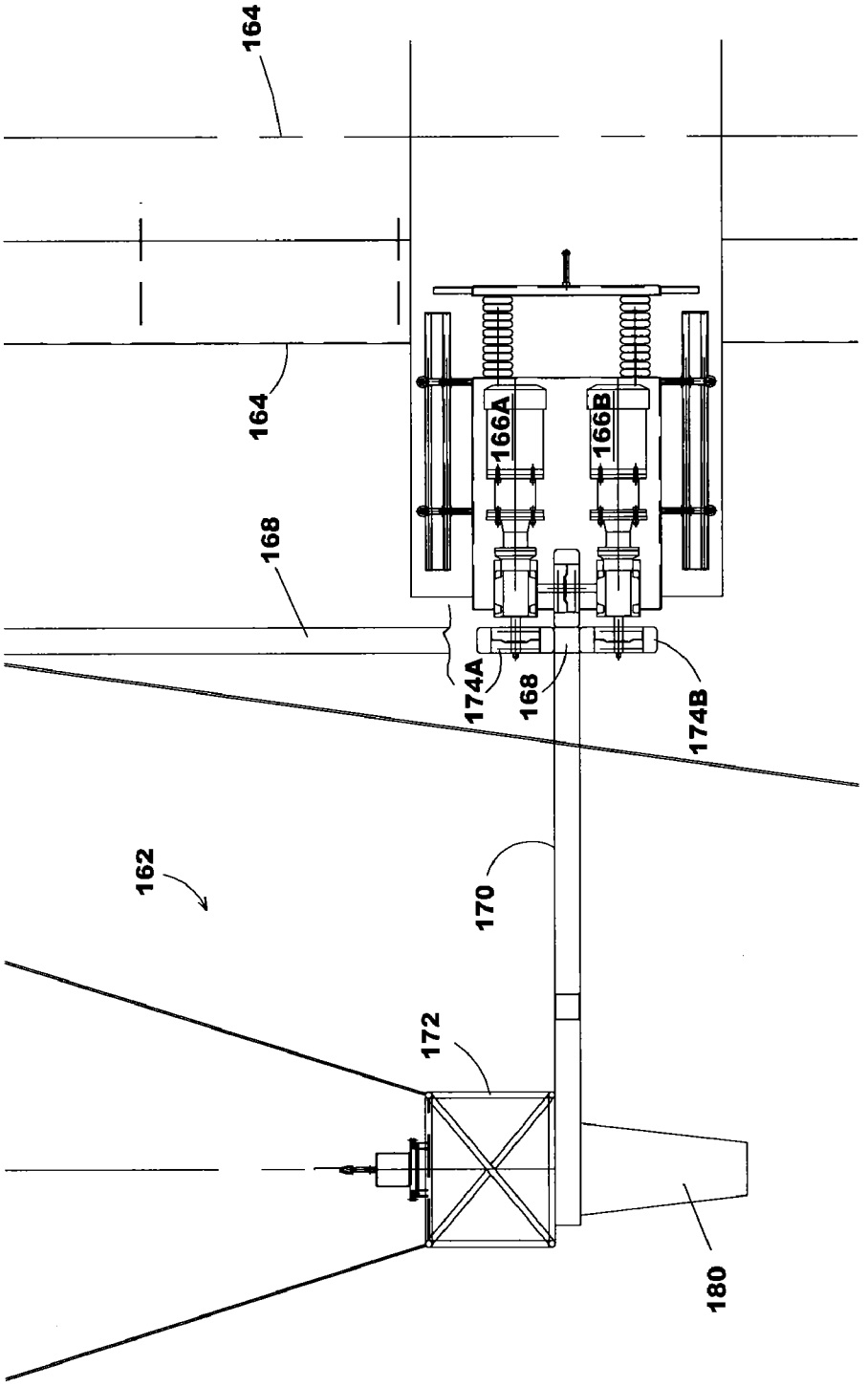


FIG. 11

FIG. 12



WIND TURBINE WITH PAIRED GENERATORS

CROSS REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of U.S. patent application Ser. No. 12/426,494, filed on Apr. 20, 2009, now U.S. Pat. No. 8,109,727 and of Ser. No. 12/432,837, filed Apr. 30, 2009, now U.S. Pat. No. 7,825,532 and of Ser. No. 12/481,817, filed on Jun. 10, 2009.

FIELD OF THE INVENTION

This invention concerns a wind turbine assembly for generating electricity in response to the movement of atmospheric wind.

BACKGROUND OF THE INVENTION

Windmills have been used for many generations for the purpose of pumping water from the ground and for generating electricity. A basic advantage of the windmill is that it uses the power of atmospheric wind to rotate a wheel having radially extending blades. This rotary movement may be converted into various useful purposes. For example, wind turbines in the form of propellers mounted on towers have been placed in areas where steady winds are prevalent and the wind turbines are used to generate electricity. An electrical generator usually is positioned near the axis of rotation of the propellers, adding the weight of the generator to the upper portion of the mast of the assembly The blades of the conventional large wind turbines are large and made of expensive rigid material and are constructed to have the blades extend radially from a central hub, with no extra support at the outer tips of the blades. The conventional wind turbine blades rotate at a high rate of revolutions and must withstand both the centrifugal forces generated by the fast revolution of the blades and the cantilever bending forces applied to the blades by the wind. Since the outer portions of the blades usually move at a very high velocity and are engaged by strong winds, the larger the blades the stronger they must be and the more expensive they become. Thus, there is a practical limit as to the length and width of the blades.

Another wind turbine type has rigid propellers that appear to be rigidly mounted to circular perimeter rims that support the outer ends of the propellers, as shown in U.S. Pat. Nos. 1,233,232 and 6,064,123. Rubber tires or other rotary objects are placed in positions to engage the outer rim so as to rotate the rubber tires, with the driven tires rotating the rotor of a generator. Thus, the rotation of the wind turbine is used to generate electricity.

The perimeter rim of a large wind turbine is likely to rotate in an irregular circular path so that at one position about the path of the rim the rim appears to wobble in an axial direction, parallel to the axis of rotation of the turbine wheel. This irregular rotation may be caused by several conditions, such as by wind turbulence, a change in wind velocity, equipment vibration, changes in wind direction, and imprecise formation and/or warping of the perimeter rim and its supporting structure. The larger the diameter of the wind turbine, the more likelihood of rotation of the rim in an irregular path and the more likelihood of greater amplitude of the axial displacement of the irregular movement of the perimeter rim.

One of the advantages of a turbine wheel with a perimeter rim is that the electrical generator(s) may be positioned at the rim at the lower arc of rotation of the rim where the generators

are closer to the ground or other low supporting surface to remove the weight of the generator from the upper portion of the mast. Also, the position of the generator at a rim of the turbine wheel gives more access for installation, maintenance, repair and replacement of the generator. However, if the perimeter rim of the wind turbine wobbles during operation, it may be difficult to maintain the generator in proper alignment with the rim and it appears likely that stress between the generator and the turbine wheel will occur. Also, if multiple ones of the generators are placed in operative locations about an arc of the rim of the turbine, the potential problems caused by the wobbling rim appear likely to be more prevalent.

While is desirable to make a wind turbine that does not wobble during rotation, from a practical viewpoint it is likely that even the more perfect wind turbines will wobble to some extent when rotating. Accordingly, it would be desirable to have a connection between the rim of a wind turbine and one or more electrical generators that accommodates the rotation of the rim when the rim tends to wobble in an axial direction.

SUMMARY OF THE DISCLOSURE

Briefly described, this disclosure concerns a wind turbine assembly for generating electricity that includes a turbine wheel mounted on a support and rotatable about a laterally extending central axis, the turbine wheel including a circular rim concentric with and rotatable about the central axis, and an electrical generator in driven relationship with the circular rim.

The wind turbine may also include sail wings formed of fiberglass or other relatively flexible material, with shape control means carried by the turbine wheel for rotating at least one of the ends of the sail wings about the longitudinal axis of the sail wings to form a pitch or twist in the sail wings.

The wind turbine may also include a moveable support configured for supporting an electrical generator and for moving the electrical generator in response to the change in axial position of the circular rim of the turbine wheel at the position of the electrical generator. The moveable support may include a pair of wheels straddling the circular rim and in driving relationship with the electrical generator.

The wind turbine assembly may further include a guide wheel in engagement with the circular rim for moving the electrical generator in response to the change in axial position of the circular rim at the position of the electrical generator.

The wind turbine may include a biasing means for urging the guide wheel into contact with the circular rim. The biasing means may include air bellows, coil springs or other means by which the wobbling of the circular rim is accommodated.

A positioning wheel may be carried by a movable support, with the positioning wheel making contact with the circular rim for moving the movable support in response to the change of position of the circular rim at the movable support. In addition to the positioning wheel, at least one driving wheel carried by the movable support may be placed in contact with the circular rim and connected to the electrical generator for driving the electrical generator in response to the rotation of the wind turbine wheel. The positioning wheel keeps the driving wheel in contact with the rim of the turbine wheel.

Other features and advantages of the structure and process disclosed herein may be understood by reading the following specification in view with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevational view of a wind turbine, according to this description.

FIG. **2** is a side cross sectional view of the wind turbine of FIG. **1**.

FIG. **3** is a detailed illustration of electrical generators and a portion of the perimeter of a turbine wheel, showing how the electrical generators may be driven by the circular perimeter rim of the wind turbine.

FIG. **4** is a detailed illustration, similar to FIG. **3**, but showing the second arrangement of the electrical generators being driven by the perimeter circular rim of the turbine wheel.

FIG. **5** is a plan view of the driven wheels and their respective generators of FIG. **4**, taken along lines **5-5** of FIG. **4**.

FIG. **6** is a side cross sectional view, similar to FIG. **4**, showing a portion of the perimeter rim of a turbine wheel and another arrangement of the electrical generators that may be driven by the perimeter rim.

FIG. **7** is a side elevational view of another wind turbine, with the wind turbine having a circular perimeter rim and an intermediate circular rim, both concentric with the axis of rotation of the turbine wheel.

FIG. **8** is a partial front view of the wind turbine of FIG. **7**, showing a portion of the turbine wheel that includes the intermediate circular rim and the electrical generators and their movable support in engagement with the intermediate rim.

FIG. **9** is a closer front view to the electrical generators of FIG. **8**.

FIG. **10** is a side elevational view of a portion of an intermediate rim of a wind turbine and the associated electrical generators of FIG. **8**, showing an alternate arrangement of the driven wheels, guide wheel, and electrical generators as mounted to the perimeter rim of the turbine wheel.

FIG. **11** is a close front view of the electrical generators, similar to FIG. **9**, but showing the electrical generators engaging an offset perimeter rim.

FIG. **12** is a side view of the turbine wheel of FIG. **11**, showing the offset perimeter rim and the sailets extending radially from the perimeter framework.

DETAILED DESCRIPTION

Referring now in more detail to the drawings in which like numerals indicate like parts throughout the several views, FIG. **1** discloses a wind turbine **20** that includes a turbine wheel **22** and has a perimeter rim **24** and a perimeter framework **26** that supports the perimeter rim. The perimeter framework is a network of angle braces **26** which supports the outer circular perimeter rim **24**. The outer circular perimeter rim may be formed of arcuate segments.

The axle structure **28** at the center of the perimeter rim defines a central axis of rotation and a plurality of sail wing assemblies **30** extend between the axle structure **28** and the perimeter framework **26**, with the sail wings extending radially from the axle structure. A plurality of cables **32** extend from the axle structure radially outwardly to the perimeter framework **26** and hold the perimeter framework in place.

As shown in FIG. **2**, the plurality of cables **32** converge inwardly as they extend from the axle structure **28** toward the perimeter framework **26**, providing both radial and axial support for the perimeter framework **26** and the perimeter rim **24**. The axle structure is mounted on an upright mast **34**, with the mast mounted on a ground support **36**. The mast may be rotated at the junction **38** between the mast **34** and ground support **36**, so as to face the turbine wheel into the oncoming wind.

Each of the sail wing assemblies **30** are rotatable about their longitudinal axis by pivotal mounting of the outer sail end supports **40** and inner sail end supports **42**. The sail end supports **40** and **42** are each mounted intermediate their ends to bearings that are supported by the perimeter framework **26** so that the sail end supports **40** and **42** rotate the sail wing assemblies about their respective longitudinal axes to adjust the pitch and twist of the sail wing assemblies so as to form the most desirable configuration of the sail wing assemblies for catching the atmospheric wind.

FIGS. **1** and **2** also show at least one electrical generator supported at the bottom arc of rotation of the perimeter rim **24** of the turbine wheel **22**. For example, FIG. **2** shows a platform **44** that supports a pair of generators **46** and **48**. Likewise, FIG. **1** shows a similar mounting of generators and platforms **44**, **46** and **48** disposed in the lowermost arc of rotation of the turbine wheel **22** in a clock-wise direction as indicated by arrow **50**.

FIG. **3** shows a generator assembly **52** that includes the platform **44** and generators **46**A and **46**B. The generators are mounted on guide support rails **54**, with an arrangement of rollers **56** engaging the rails **54**. This allows the generators to be moved axially, in the direction of the axis of rotation of the turbine wheel, which is left and right as shown by the double headed arrow **66** in FIG. **3**.

Each generator is connected to a reduction gear **58**A, **58**B, respectively, and drive shafts **60**A and **60**B extend from the reduction gears to a wheel member **62**A, **62**B, respectively. The wheel members may be conventional rubber tires mounted on rims, but other rotary type wheel members may be used, as desired.

Perimeter rim **24** has opposite facing parallel surfaces that are engaged by the wheel members **62**. In order to assure proper engagement of the wheel members **62** with the perimeter rim **24**, a turnbuckle **64** connects the reduction gear housings of the reduction gears **58** so that when the turnbuckle **64** is tightened, the wheel members compress against opposite surfaces of the perimeter rim **24**, causing the wheel members **62** to rotate in response to circumferential movement of the perimeter rim **24**.

With the arrangement of the generator assembly **52** of FIG. **3**, it can be seen that should the perimeter rim **24** experience some axial movement or wobbling as indicated by arrows **66**, the generator assembly will be able to move in the same directions and at the same amplitude of the axial movement **66** while the wheel members **62**A and **62**B retain positive engagement with the perimeter rim **24**. Since the turnbuckle **64** tends to clamp the wheel members **62**A and **62**B into engagement with the perimeter rim **24**, continuous rotary movement will be imparted from the perimeter rim **24** to the wheel members **62**A and **62**B, and the rotary motions from the wheel members will be transmitted through the drive shafts **60**A and **60**B, reduction gears **58**A and **58**B to the generators **46**A and **46**B.

FIG. **4** shows another form of generator assembly **72** which includes generators **76**A and **76**B that are mounted by horizontal support arms **74**A and **74**B, respectively, and the support arms are pivotally mounted to the upright support shaft **75** that is supported, in turn, by the platform **44**.

The reduction gears **78**A and **78**B connect the generators **76**A and **76**B through the drive shafts **80**A and **80**B to the wheel members **82**A and **82**B that engage the perimeter rim **24**. The turnbuckle **84** is connected to the reduction gears **78**A and **78**B, drawing the generators **76**A and **76**B, reduction

gears **78**A and **78**B, and the wheel members **82**A and **82**B together so that the wheel members **82**A and **82**B make positive engagement with the perimeter rim **24** of the turbine wheel **22**.

As shown in FIG. **5**, which is a top view taken along lines **5-5** of FIG. **4**, the horizontal support arms **74**A and **74**B are pivotally connected to the upright support shaft **75** so that they are movable about the upright support shaft **75** in arcs as indicated by the double-headed arrows **86**A and **86**B. This allows the wheel members **82**A and **82**B, the reduction gears **78**A and **78**B, and the generators **96**A and **96**B to oscillate in unison in the directions indicated by the arrows **86**A and **86**B, thereby compensating for axial movement of the perimeter rim **24**.

FIG. **6** shows yet another embodiment of the generator assembly **92**. The generators **96**A and **96**B, their respective reduction gears **98**A and **98**B and their drive shafts **100**A and **100**B are driven by the wheel members **102**A and **102**B that are in engagement with the perimeter rim **24** of the turbine wheel **22**. The turnbuckle **104** maintains the wheel members **102**A and **102**B in constant compressive contact with respect to the opposite facing surfaces of the perimeter rim **24**. Horizontal support arms **104**A and **104**B support the drive shafts **100**A and **100**B on the upright support shaft **105**, similar to that arrangement shown in FIG. **5**.

The upright support shaft **105** of FIG. **6** is mounted on guide support rails **108** that are mounted in turn to the platform **44**. The movable connection made by the rollers **106** against the guide support rails allows the generator assembly **92** to move axially, parallel to the axis of rotation of the turbine wheel, as indicated by double-headed arrow **109**. This allows the generator assembly **92** to move in response to the axial movement or "wobbling" of the perimeter rim **24** so that the wheel members **102**A and **102**B maintain constant engagement with the perimeter rim **24**.

FIG. **7** illustrates another embodiment of a wind turbine **110** that includes a turbine wheel **112** having a perimeter rim **114** and a perimeter framework **115** and an intermediate framework **116** and an intermediate rim **117**. As shown in FIG. **8**, the intermediate framework **116** is structured in a manner similar to the structure of the perimeter framework **114** in that it includes a network of angled braces and is formed in a circle that is coaxial with both the perimeter rim **114** and the central axis of rotation **119**. A series of intermediate sail wings **120** are supported at their inner ends by the axle structure **118** and at their outer ends by the intermediate framework **116**. Likewise, outer sail wing assemblies **121** are supported at their ends by intermediate framework **116** and perimeter framework **115**.

As shown in FIG. **7**, a series of axially extending spars **124** are supported by the intermediate framework **116**, and intermediate rim **117** is supported by the spars **124**. The intermediate rim **117** is positioned between the mast **128** and the cables **130** and **132** so that it is outside of the cables **130** and **132** that extend from the axle structure **118** out to the perimeter framework **115** and the intermediate framework **116**.

As shown in FIGS. **9** and **10**, electrical generators **140**A and **140**B are supported adjacent the intermediate rim **117** in the lower arc of movement of the intermediate rim **117**. Support plate **142** is rigidly mounted to the mast **128**. The electrical generators **140**A and **140**B are mounted on movable support **144**. Movable support **144** is mounted to guide support rails **148** so that the movable support **144** moves with respect to mast **128** as indicated by the double-headed arrow **150**. The electrical generators **140**A and **140**B are operatively connected through the gear reducers **152**A and **152**B, and the gear reducers are connected in turn to the wheel members **154**A and **154**B, respectively. A turnbuckle (not shown in FIG. **10** but similar to turnbuckle **64** of FIG. **3**) connects the gear reducers **152**A and **152**B together so that the wheel members are in positive engagement with the opposite surfaces of the intermediate rim **117** of the turbine wheel.

As shown in FIG. **10**, guide wheel **156** is supported on the movable support **144** and engages the outward facing lateral surface of the intermediate rim **117**.

At the other end of the movable support **144** is a biasing means for urging the guide wheel **156** into constant contact with the outward face of the intermediate rim **117**. The biasing means may include bellows **158**A and **158**B that are backed at one end against a stationary plate **160** and which engage the adjacent edge of the movable support **144**. In the alternative, a coil spring or other biasing means may be used to continuously urge the guide wheel **156** into engagement with the intermediate rim **117**. This maintains the wheel members **154**A and **154**B in aligned contact with intermediate rim **117**. Thus, if there is any axial wobbling of the intermediate rim **117**, the guide wheel will follow the axial movement of the intermediate rim, moving the support **142**, generators **140**A and **140**B and associated structure axially as shown by barrow **150**, maintaining the wheel members **154** in constant contact with the intermediate rim **117**. This avoids interruption of the rotary movement applied by the intermediate rim **117** to the wheel members **154**A and **154**B.

FIGS. **11** and **12** show a turbine wheel **162**, mast **164**, and electrical generators **166**A and **166**B that are similar to those of FIG. **9**. However, the perimeter rim **168** is offset from the perimeter framework **172**, as shown in FIG. **12**. The plurality of spars **170** support the perimeter rim **168** from the perimeter framework **172**. The electrical generators are movably mounted with respect to the mast **164** as previously described so that the wheel members **174**A and **174**B engage opposite sides of the perimeter rim **168**, as previously described. The guide wheel **176** bears against the adjacent surface of the perimeter rim **168**, keeping the wheel members **174**A and **174**B in proper alignment with the perimeter rim **168**.

A plurality of short sail wings, identified as "sailets," **180** are attached to the perimeter framework **172**, extending radially outwardly from the perimeter framework **172**. The sailets **180** are angled so as to form a pitch with respect to the oncoming atmospheric wind. The sailets typically will be rigid and relatively short in comparison to the sail wings of the turbine wheel so that they do not require additional support at their outer ends. The sailets provide additional surfaces for catching the wind and therefore increase the force of the rotary motion taken by the wind turbine from the oncoming wind.

It will be understood by those skilled in the art that while the foregoing description sets forth in detail preferred embodiments of the present invention, modifications, additions, and changes might be made thereto without departing from the spirit and scope of the invention, as set forth in the following claims.

The invention claimed is:

1. A wind turbine assembly for generating electricity, comprising:

a turbine wheel support member,

a wind turbine wheel mounted on said turbine wheel support member, said wind turbine wheel including a laterally extending central axis of rotation, a circular perimeter rim concentric with and rotatable about said central axis of rotation, and a circular intermediate rim concentric with said perimeter rim and positioned between said perimeter rim and said central axis of rotation and rotatable about said central axis of rotation,

intermediate sail wings supported between said central axis of rotation and said circular intermediate rim, and outer sail wings supported between said circular intermediate rim and said circular perimeter rim,

an electrical generator mounted in engagement with one of said circular intermediate rim and said circular perim-

eter rim for generating electricity in response to the rotation of said wind turbine wheel,

a movable support configured for supporting said electrical generator and for moving said electrical generator in response to a change in the axial position of said one of said circular intermediate rim and said circular perimeter rim at the electrical generator, and

a positioning wheel carried by said movable support and in contact with one of said perimeter rim and said intermediate rim for moving said movable support in response to the change of position of the circular rim at said movable support.

2. The wind turbine assembly of claim **1** and wherein said positioning wheel includes a pair of wheels straddling said one of said circular intermediate rim and said circular perimeter rim and in driving relationship with said electrical generator.

3. The wind turbine assembly of claim **2** wherein said movable support further includes biasing means for urging said positioning wheel into contact with one of said circular intermediate rim and said circular perimeter rim.

4. The wind turbine assembly of claim **3** wherein said biasing means includes an air bellows.

5. The wind turbine assembly of claim **3** wherein said biasing means includes a spring.

6. A wind turbine assembly for generating electricity, comprising:

a turbine wheel support member,

a wind turbine wheel mounted on said turbine wheel support member, said wind turbine wheel including a laterally extending central axis of rotation and a circular rim rotatable about said central axis of rotation,

sail wings supported by said circular rim,

an electrical generator mounted in driven relationship with said circular rim for generating electricity in response to the rotation of said wind turbine wheel,

a movable support configured for moving in response to a change in the position of said circular rim at the electrical generator for maintaining said electrical generator in driven relationship with said circular rim,

a positioning wheel carried by said movable support and in contact with said circular rim for moving said movable support in response to the change of position of the circular rim at said movable support, and

at least one driving wheel carried by said movable support in contact with said circular rim and connected to said electrical generator for driving said electrical generator in response to the rotation of said wind turbine wheel.

7. The wind turbine assembly for generating electricity of claim **6**, wherein

said circular rim includes a laterally facing surface and opposed vertically facing surfaces,

said positioning wheel engages said laterally facing surface of said circular rim, and said at least one driving wheel comprises a pair of opposed driving wheels each engaging one of said opposed vertically facing surfaces of said circular rim.

8. The wind turbine assembly for generating electricity of claim **6**, wherein

said electrical generator comprises a pair of electrical generators,

said at least one driving wheel comprises a pair of driving wheels for engaging opposite sides of said circular rim, and

each driving wheel of said pair of driving wheels in driving engagement with one of said electrical generators of said pair of electrical generators.

9. The wind turbine assembly for generating electricity of claim **6**, wherein said movable support is mounted on a bearing.

10. The wind turbine assembly for generating electricity of claim **9**, wherein said bearing is formed of wheels.

11. The wind turbine assembly for generating electricity of claim **6**, and further including sailets extending radially from said circular rim.

12. The wind turbine assembly of claim **6**, wherein

said movable support includes bellows configured maintaining said positioning wheel in contact with said circular rim during lateral movements of said rotor.

13. A wind turbine assembly comprising:

a support,

a turbine wheel rotatably mounted on said support about a laterally extending central axis,

said turbine wheel including a circular rim concentric with and rotatable about said central axis, said circular rim including opposed surfaces,

an electrical generator assembly in driven relationship with said circular rim,

said electrical generator assembly including a pair of driving wheels for straddling said circular rim in driven relationship with said opposed surfaces of said circular rim, and including an electrical generator in driven relationship with each of said driving wheels,

biasing means configured for maintaining said driving wheels in driven relationship with said circular rim, and

a positioning wheel in contact with said circular rim and configured for moving said electrical generators in response to the change of position of the circular rim at said positioning wheel.

14. The wind turbine assembly of claim **13**, wherein said biasing means comprises a turn buckle.

15. The wind turbine assembly of claim **13**, and wherein said pair of driving wheels comprises one wheel in driving relationship with one electrical generator and a second wheel in driving relationship with another electrical generator.

16. A wind turbine assembly comprising:

a turbine wheel rotatably mounted about a laterally extending central axis,

said turbine wheel including a circular rim concentric with and rotatable about said central axis, a plurality of sail wings each including an inner end and an outer end, and a longitudinal axis extending between said inner end and said outer end and extending radially from said central axis to said circular rim,

said sail wings are formed of fiberglass and are bendable about their longitudinal axis,

an electrical generator in driven relationship with said circular rim, and

a pair of wheels for engaging opposite surfaces of said circular rim for driving said electrical generator,

biasing means configured for urging said pair of wheels into engagement with said opposite sides of said rim, and

a positioning member positioned adjacent said circular rim and configured for moving said electrical generator in response to the change of position of the circular rim at said electrical generator.

17. The wind turbine assembly of claim **16**, wherein said rim is supported by cables extending between said rim and said laterally extending central axis.

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